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PRODUCTION

JANUARY 1985

Controls—The Factory Genius. . . p. 32

1985 Capital Spending—Up 13 Percent. . . p. 38
FMS in Action. . . p. 41

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Production Publishing Company, Inc.
Vol. 95 No. 1

PRODUCTION®

January 1985

Controls—The Factory Genius
Today's controls are so sophisticated they make complex programming simple. Diagnostics speeds repairs and reliable electronics maximizes machine uptime....32

1985 Capital Spending—Up 13%
Nearly half of this year's Capital Spending Survey respondents indicate increased incoming orders as the basis for their spending boost....38

FMS In Action
Leading builder opts for FMS to produce machine tool components and contract work....41

Buying Now Avoids 'Paying' Later
Periodic new machine purchases can keep facilities modern and technology current....44

'I Don't Know How We Did It!'
More than 100 new CNC machines were installed in 18 months at GE's Wilmington, NC, plant using an "assembly line" technique....46

Shankless Boring Unit Replaces Boring Bar
Shankless cutting tools double tool life in machining axle shaft tube bore diameters in nodular iron rear axle differentials at Ford....49

Air Tools Picked for 'Clean Room' Use
Contrary to conventional wisdom, air-powered tools can be used in super-clean environments....51

Golden Gloves
Something as seemingly inconsequential as work gloves, if properly matched to the job, can mean increased safety and considerable savings....53

Manufacturing Strategies No. 4

Confidentiality: An Essential to Competitiveness
Robert Lindner of Newcor Inc. Machine Tool Group discusses the challenge in maintaining customers' proprietary systems designs....55

What's New....58

- Laser Robot Cell
- Turning on Track
- Rebuilt Grinder Saves Money
- Predicting Paintability

5 EDITORIAL

11 NEWSBITS
Manufacturing Outlook
Industry Report
Technology Updates
Robotics/Automation
Assembly

23 VIEWPOINT
by Michael Hora
A. T. Kearney, Inc.

30 STRICTLY PERSONAL

61 NEW LITERATURE

64 NEW EQUIPMENT

71 ADVERTISERS INDEX

72 FOR YOUR INFORMATION

73 READER SERVICE CARD

THE COVER:
As the human brain controls the body, today's electronic devices are integrating and controlling the factory. Computer graphics by VuCom Graphicsystems, Troy, MI.

NEXT MONTH:
A PRODUCTION Round Table. Seven machine builder and manufacturing executives share their views about Justifying New Manufacturing Technology.

Published by Production Publishing Company, Inc., Box 101, Bloomfield Hills, Michigan 48303-0101 (313) 647-8400

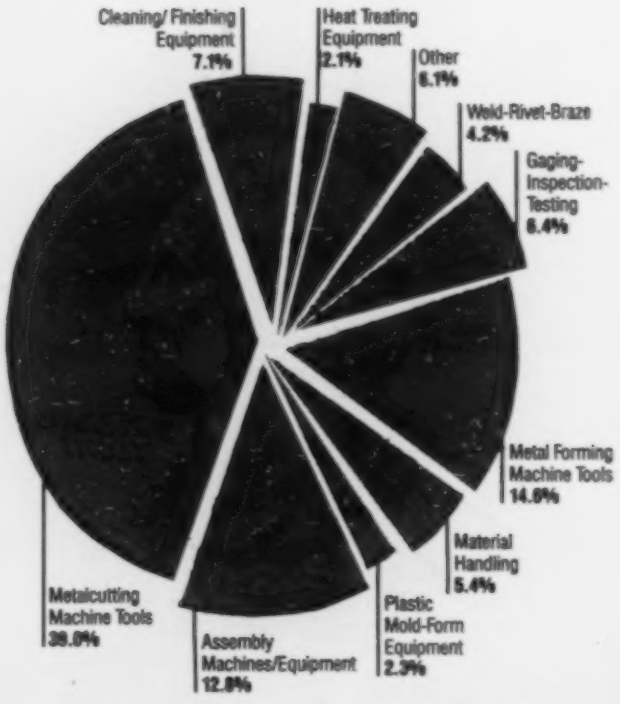
1985 Capital Spending *Up 13%*

Edward D. McCallum Jr.
Director-Research & Operations

With slightly over half of you (51.0%) planning to increase spending this year over 1984, and with almost half of you reporting increased incoming orders as the basis for spending growth, we look for capital spending to make a significant contribution to the continuing growth of the economy this year.

How the 1985 Capital Equipment Dollar Will Be Spent

Percent of Investment



Source: PRODUCTION's Capital Spending Forecast 1985-86

All this is on top of a good 1984 spending performance.

This pushes capital spending up to $10.5 billion from the $9.3 billion we projected for 1984. That's up 13.1 percent. While this spending level does not match spending patterns of five years ago, it does represent a nice improvement from a few years ago when spending fell to about $7.0 billion.

Our 1985 findings, obtained through our annual survey* conducted in August, checks your spending plans for machinery and equipment purchases, and the reasons behind those plans.

The overall profile . . .

You're typical if your plant is planning to apportion its investment for machinery and equipment as depicted by the following table:

Machine/Equipment	Percent of Total Investment 1985	Projection (Mil $)	Percent Change 1985 from 1980-1984 Average
Metalcutting	39.1%	4327*	+10.8%
Metal Forming	14.6%	1536**	+26.9%
Assembly	12.8%	1347	−12.3%
Cleaning/Finishing	7.1%	747	− 1.4%
Gaging/Inspection/Testing	6.4%	673	+ 3.2%
Materials Handling	5.4%	568	−11.5%
Weld/Rivet/Braze	4.2%	442	−20.8%
Plastic Molding	2.3%	242	−18.0%
Heat Processing	2.1%	221	−16.0%
Other	6.0%	642	−29.9%

* $2730 million to be sourced domestically
** $1136 million to be sourced domestically

Survey Scope: Plants reached by PRODUCTION Magazine in: Fabricated Metal Products (SIC 34); Machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); and Instruments (SIC 38). 1985 figures are projected from 1834 respondents from 10,000 plants contacted in keeping with past procedures.

Ycu're also typical if in 1985. . .

Your plant employs	Your machinery/equipment expenditures are
Less than 50 persons	$ 140,722
50-99 persons	$ 180,673
100-499 persons	$ 532,189
500-999 persons	$1,305,189
1000 or more persons	$3,939,057

What's more . . .

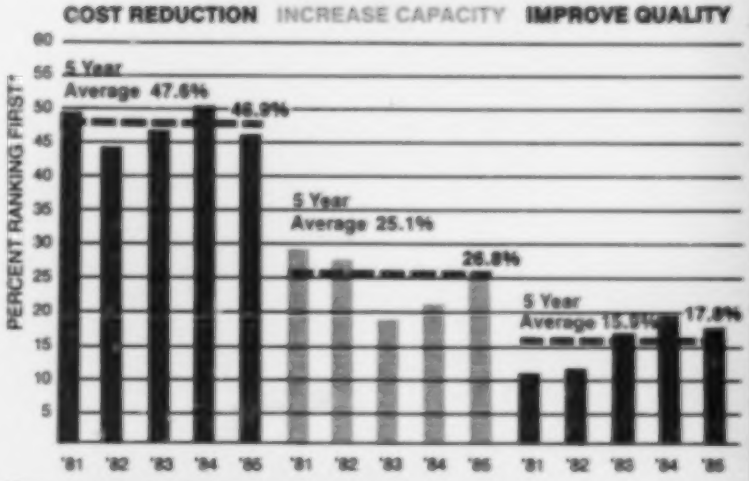
• You reported you were operating at 77 percent of capacity in August of 1984 which is the highest level since Fall 1981. (At the time we went to press you were operating around 81 percent.) 61.6 percent of you plan to operate at a higher level of capacity in 1985, while only 3.7 percent think they'll be operating at a lower level. The remainder plan to operate at the same level as last year which was up over the year previous. And with almost half of you (46.9%) reporting incoming orders on the increase and another 18.8 percent reporting their incoming orders are holding steady, we believe planned capacity use is based on strong expectations of business instead of optimistic hopes.

• Your financial people are not making it easier to justify production equipment with first-year return-on-investment (pre-tax) requirements of 32 percent on average. These requirements have been virtually unchanged over the last five surveys.

• While 35 percent of you reported having approved budgets as of last August, about half of you (47.1%) did not expect approvals until year-end 1984. The balance expects action during the first quarter of this year. IMPORTANT NOTE: As a group, the 65 percent then awaiting approval estimated they expected to receive only 75 percent of funds requested. And, only 9 percent of planned-for equipment was already on order with builders, which reflects the short leadtimes offered customers in today's environment.

• You continue to increase the share of capital dollar expenditures for metalcutting and metal forming machine tools. This year these two categories account for 53.7 percent of all machinery/equipment expenditures—39.1 percent for metalcutting and 14.6 percent for metal forming. These are taking the highest proportion of the equipment dollar since 1969.

Overall Motives for Planned Machinery/Equipment Investments Total Respondents 1981-1985



*Some respondents ranked more than one motive first
Source: PRODUCTION's Capital Spending Forecasts 1981-1985

Cost reduction continues as the primary motive to buy equipment; however, the need to increase capacity has become more important as industry steps up its capacity utilization rate. Quality improvement continues as the third most important motive. Other motives, not graphed, include: New products/models—14.4 percent ranking first; machine/process flexibility—8.2 percent ranking first; more make-less buy—7.0 percent ranking first; followed by energy reduction—ranked first by only 3.3 percent of the respondents.

• Over the next three years, 52.1 percent of total survey respondents plan to purchase CNC equipment. 62.8 percent of the total respondents report use of CNC, up from 59.3 percent in last year's survey and 55.9 percent two years ago. Horizontal and vertical machining centers and horizontal turning machines will continue to capture the lion's share of the CNC purchases over the next few years.

• 11.3 percent of total respondents are planning EDM purchases over the next three years, up from 10 percent last year. Over one in five plants (21.0%) reports use of EDM.

About 65 percent of those plants planning EDM purchase will buy wire-cut machines.

• 15.9 percent of you will buy lasers in 1985-87. Of these: 14.4 percent will use the laser for drilling operations, 25.6 percent for welding, 28.1 percent for cutting, 7.2 percent for heat treat, and 53.8 percent for gaging/measurement. Laser types planned: 24.3 percent, CO_2 lasers; 18.8 percent, YAG; and 18.5 percent, helium-neon.

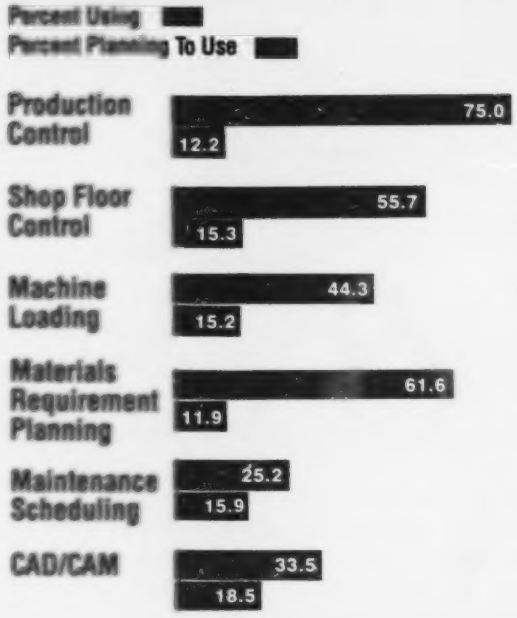
• 46.5 percent of the total respondents report they will purchase a portion of their equipment needs from offshore sources. The breakdown: 50.8 percent plan offshore metalcutting machine purchases; 16.3 percent plan metal forming purchases; 11.7 percent plan gaging/inspection/testing purchases. Reasons given for offshore sourcing: equipment quality (70.4%), price (65.5%), availability (38.6%), and service (22.7%).

Use of Advanced Manufacturing Technologies

Manufacturing Cells. 17.2 percent of you report your plans include purchase of manufacturing cells in 1985-87. Of these, 93.7 percent are located in plants employing 100 or more persons—52.7 percent in plants with 500 or more persons. The typical plant planning cell purchase will spend slightly more than $1,000,000 for capital equipment (median). 20 percent of these plants planning cell purchase will spend between $1,500,000 and $160,000,000 in 1985. (A cell is defined as comprising one materials handling device servicing multiple machines, coordinated and paced by a computer or programmable controller.)

Flexible Manufacturing Systems. 14.7 percent of all plants responding plan purchase of FMSs over the next three years. 92.4 percent of these plants employ 100 or more persons. 17.1 percent of those respondents planning to purchase FMSs in 1985-87 (46 manufacturing locations) will spend $771 million on production equipment during 1985. Of these 46 locations, five are in Fabricated Metal Products (SIC 34), 18 are in Machinery, except Electrical (SIC 35), 14 are in Electrical Machinery (SIC 36), seven are in Transportation Equipment (SIC 37), and two are in Instruments (SIC 38). FMSs in these areas include metalcutting, metal forming and assembly-oriented systems. (An FMS was defined in the survey as comprising multiple materials handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.)

Computerized Data Systems' Usage



Robotics. 36.9 percent of the responding plants will buy robots in the next three years. Three years ago the figure was 21.6 percent; two years ago, 30.5 percent; last year, 33.9 percent. Robot usage and planned usage breaks down as follows:

Robot Use	Current	Additional Planned Purchases
Arc Welding	8.3%	4.7%
Spot Welding	3.1%	2.2%
Assembly	11.9%	7.3%
Load/Unload	19.2%	9.7%
Material Handling	10.9%	6.3%
Spray Paint	6.7%	5.1%
Other	2.3%	0.9%

Computers. 78.7 percent of you plan to apply computers in your manufacturing operations in the next three years. Use of computerized data systems in your plants continue to expand as your needs to control and improve your manufacturing costs accelerate. ■

C79 75-1

PRODUCTION's

Manufacturing PLANNING

CIM Must Start at the Top
- It must be fully integrated into factory operations
- Management must be determined to make it work

Capital Spending Forecast 1985-86
- $10.5 billion projected
- Informative charts & graphs

Annual Technology Update
- Hundreds of new developments
- Interpretive descriptions

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Vol. 95 No. 3

PRODUCTION®

March 1985

CIM Must Start at the Top 43

Computer Integrated Manufacturing (CIM) must be completely integrated into an entire factory operation if it is to be economically effective. And, it must start at the top — company management must be determined to make it successful, says Thomas G. Gunn, vp-Arthur D. Little. An effective system must be based on carefully developed and implemented strategies that are aimed at providing large-scale benefits.

Capital Spending — 1985-86 53

PRODUCTION's 10th annual Capital Spending Survey projects that the manufacturing industry will invest $10.5 billion in new equipment during 1985-86 — 13 percent more than last year. Largest share of the pie will be invested in metal forming and metalcutting machinery. Manufacturing cost reductions, utilization of new technologies, reduced labor costs and improved material utilization are cited as primary reasons for the upcoming increase in capital spending.

Your Company Can Be Competitive Internationally 64

Do you know how to respond to overseas competitors who have introduced tougher standards for costs, quality and delivery? First of all, you must have the confidence to be a viable competitor. Next, it will be helpful to read the seven little-understood reasons why you may fail, as presented by Ingersoll Engineers' Robert L. Callahan in this editorial feature. And last, take a fresh, new look at your method of equipment justification. A new approach could spell S-U-R-V-I-V-A-L for your company.

Update 73

The Update section is designed to acquaint you with the latest developments for a wide variety of manufacturing improvements. It contains brief descriptions of over 450 products that have been introduced or upgraded during the past year.

5 EDITORIAL

17 NEWSBITS
Manufacturing Outlook
Washington Impact
Industry Report
Technology Update
Robotics/Automation
Assembly

35 STRICTLY PERSONAL

128 ADVERTISERS INDEX

129 READER SERVICE CARD

THE COVER:
The alphanumeric headline, end milled in a metal plate, depicts the expected long life of PRODUCTION's 1985-86 PLANBOOK. Machining courtesy of Kearney & Trecker Corp.

NEXT MONTH:
Cover feature examines various net shape manufacturing processes which present opportunities to improve material utilization and reduce overall costs.

Published by Production Publishing Company, Inc., Box 101, Bloomfield Hills, Michigan 48303-0101 (313) 647-8400

voluntary action and have detailed "best practices" for firms to follow in a *Managing Plant Closings* guidebook. The hope is to spur medium and small businesses to plan for a shutdown by taking steps to help soften the impact of any future plant closings.

Big Payoff

The Small Business Innovation and Development Act is beginning to pay off big for hundreds of small high-tech companies. It provided for the Small Business Innovation Research (SBIR) program that awards up to half a million dollars in research contracts to qualifying concerns. The law was designed to bring new technologies to the marketplace.

Large corporations are watching those firms that win very carefully, with an eye to moving in when the research and development is ready for commercialization. The Pentagon is the biggest player of the dozen federal agencies. DOD wants to sponsor development of hardware it can buy in the future.

Not to be outdone, the space agency, which is among the largest applied research buyers, picked 58 out of the 103 for awards that totalled $25 million in 1984. ■

INDUSTRY REPORT

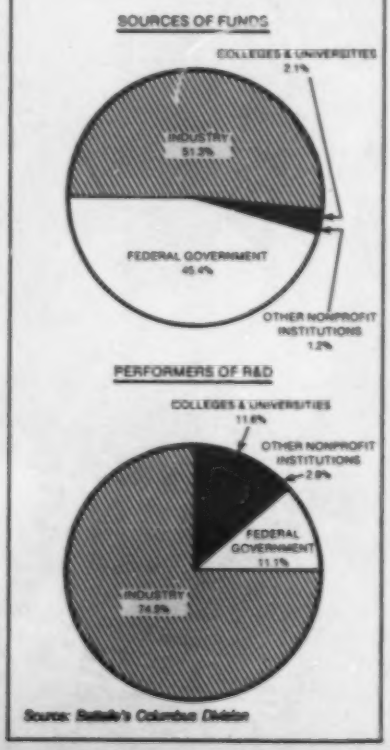
Industry To Spend $80 Billion for R&D

Expenditures for research and development in the U.S. for 1985 are expected to reach almost $107.3 billion, with industry accounting for 74.5 percent of all research performed. This according to the annual forecast of Battelle Memorial Institute, one of this country's foremost research organizations.

This represents an increase of $10.3 billion (10.6%) over the $97.0 billion that the National Science Foundation estimates was actually spent for R&D in 1984.

Industry will remain as the dominant force in R&D with their funding approaching $80 billion in 1985. Additionally, this support of R&D is expected to increase in the coming years, largely through cooperative programs between universities and consortia of industries.

R & D Expenditures in the U.S. Calendar Year 1985



Source: Battelle's Columbus Division

Standards for Factory Floor Communications

The MAP (Manufacturing Automation Protocol) Users Group met this January at The National Bureau of Standards' Gaithersburg, MD, facility for a two-day forum on standards to improve factory floor communication. User and vendor organizations such as GM, Ford, Eastman Kodak, IBM, Hewlett-Packard—185 companies in all—reported on their current levels of commitment to the MAP approach to product development and use.

A formalized group within the Society of Manufacturing Engineers, the MAP Users Group is administered by its Computer and Automated Systems Assn. (CASA/SME). The Group is dedicated to improving manufacturing productivity through implementation of a common communications standard for various manufacturers' hardware processors and factory floor devices. The MAP Users Group supports a standard set of communication specifications using General Motors' MAP document as a reference.

When fully implemented, these standards will:

- Lower factory floor system costs
- Improve the flexibility and adaptability of production systems
- Allow wider choice in suppliers
- Shorten the leadtime in designing and implementing integrated manufacturing systems.

Global HIP Market Grows

A major multi-client study by 12 internationally known experts was recently completed at Gorham In-

Capital Spending 1985-86

Edward D. McCallum Jr.
Director-Research & Operations

Trends, Objectives/Motivations

Each year, the Research Div. of Production Publishing Co., Inc., surveys the metalworking industry's capital spending plans for machinery and equipment. In addition to determining how funds will be allocated, the study also reveals reasons for spending.

Salient data is provided here in charts and tables to help you compare your spending plans — and previous performance — with overall trends and with others in your particular industry. It may provide you with a feeling about your competitive manufacturing capability. And it may furnish support for your request for capital funds.

Those of you who responded to our 1984 survey called the upswing in capital spending last year. You said machinery and equipment expenditures would be up by 32 percent over 1983 — and you missed the target by only a few percentage points. For 1985, the data you provided projects an increase to $10.5 billion — up 13 percent — on top of the substantial jump last year. This compares with $9.3 billion in 1984 and $7.0 billion in 1983.

Here's how you report you will apportion your machinery and equipment investments in 1985:

Machines/Equipment	Percent of Total Investment 1985	Projection (Mill $)	Percent Change 1985 from 1980-1984 Average
Metalcutting	39.1%	4327*	+10.8%
Metal Forming	14.6%	1536**	+26.9%
Assembly	12.8%	1347	−12.3%
Cleaning/Finishing	7.1%	747	− 1.4%
Gaging/Inspection/Testing	6.4%	673	+ 3.2%
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Weld/Rivet/Braze	4.2%	442	−20.8%
Plastic Molding	2.3%	242	−18.0%
Heat Processing	2.1%	221	−16.0%
Other	6.0%	642	−29.9%

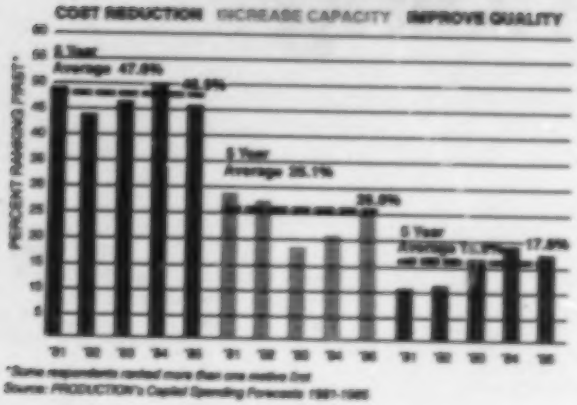
*$2730 million to be sourced domestically
**$1136 million to be sourced domestically

Traditional Spending Restored. More than half of you (51.0%) plan to increase spending in 1985 compared to 1984. Another 35.2 percent report you'll spend at the same level as last year. Only 11.4 percent report they'll spend less. These spending intentions are reinforced by the average spending levels reported by plant employment size. The table, below, reports spending, on average, is at about the same level as in 1981. It took industry four years to get back to the more traditional spending levels. During that period, investments have been unnaturally low.

Your plant employs	Your machinery/equipment expenditures are
Less than 50 persons	$ 140,722
50-99 persons	$ 190,673
100-499 persons	$ 532,189
500-999 persons	$1,305,189
1000 or more persons	$3,939,057

Survey Scope: Plants reached by PRODUCTION Magazine in: Fabricated Metal Products (SIC 34); machinery, except Electrical (SIC 35); Electrical Machinery (SIC 36); Transportation Equipment (SIC 37); and Instruments (SIC 38). 1985 figures are projected from 1834 respondents from 10,000 plants contacted in keeping with past procedures.

Overall Motives for Planned Machinery/Equipment Investments Total Respondents 1981-1985


COST REDUCTION
INCREASE CAPACITY
IMPROVE QUALITY
PERCENT RANKING FIRST*
5 Year Average 47.6%
5 Year Average 35.1%
5 Year Average 17.8%
'81 '82 '83 '84 '85 '81 '82 '83 '84 '85 '81 '82 '83 '84 '85

*Some respondents ranked more than one motive 1st
Source: PRODUCTION's Capital Spending Forecasts 1981-1985

Cost reduction continues as the primary motive to buy equipment; however, the need to increase capacity has become more important as industry steps up its capacity utilization rate. Quality improvement continues as the third most important motive. Other motives, not graphed, include: New products/models—14.4 percent ranking first; machine/process flexibility—8.2 percent ranking first; more make-less buy—7.0 percent ranking first; followed by energy reduction—ranked first by only 3.3 percent of the respondents.

Objective/Motivation. Your confidence in your ability to fund 1985 capital investment is supported by the increase in operating rate you reported in the survey (77 percent overall last summer, 81 percent as of now) and your plans to operate at higher levels this year than last. Only 3.7 percent of you thought your plant would operate at a lower level in 1985 than in 1984. And your plans seem to be based on stronger business instead of optimistic hopes and forecasts as was the case a few years ago.

You report it isn't getting any easier to justify your capital investment. ROIs, on average, still call for 2¾-year paybacks.

Almost half of you (46.5%) will globally source some of your 1985 equipment needs. Of these: 50.8 percent plan offshore purchases of metalcutting equipment, 16.3 percent metal forming and 11.7 percent gaging/inspection equipment. Reasons given for offshore sourcing: equipment quality (70.4%), price (65.5%), availability (38.6%—down from last year's survey due to current short leadtimes for domestically produced capital equipment) and service (22.7%).

Most of you (66.4%) continue to report direct labor as the primary cost reduction target for 1985 capital investment. We have to assume that emphasis is on assembly operations because you regularly attribute somewhere between 10 and 15 percent of your costs to direct labor content in fabrication. Other key cost reduction efforts targeted for investment are: materials costs, 28.7 percent; in-process inventory, 28.5 percent; scrap-rework, 23.7 percent; indirect labor, 20.0 percent; and perishable tools and supplies, 8.0 percent.

Planning for 'New' Manufacturing Technologies

Advanced manufacturing technologies continue to account for an increasing share of your time and money. In the following paragraphs we're looking at buying intentions for manufacturing cells and flexible manufacturing systems, robotics, laser systems, electrical discharge machines, numerical control and computers.

Cells and Systems

A little less than one-fifth of total respondents (17.2%) report their plans include purchase of manufacturing cells over the next three years. (A cell is defined as comprising one materials handling device servicing multiple machines, coordinated and paced by a computer or programmable controller.) The percentage of those planning cells is up considerably from the 14 percent reported in last year's survey.

Almost 15 percent of you (actually, 14.7%) plan purchase of FMSs (flexible manufacturing systems) over the same time-frame. (An FMS is defined in the survey as comprising multiple materials handling devices servicing multiple machines with a computer responsible for coordinating, pacing and scheduling.) This category is also notably up from last year's 11.5 percent.

Based on the above definitions, here are the key industries that report plans for 1985-87 purchases of each type with the percentage each industry accounts for of the reported base:

Plan To Purchase Cells and Systems 1985-87

SIC	Industry	Percent Respondents Planning: Cell Purchase Base: 315 plants	Systems Purchase Base: 269 plants
346	Forgings and stampings	-	2.9%
3494	Valves and pipe fittings	3.8%	3.7%
351	Engines and turbines	3.4%	3.3%
352	Farm and garden machinery	2.2%	-
3531-8-9	Construction machinery, mining and oil field machinery	5.0%	4.0%
354	Metalworking machinery	7.3%	7.4%
356	General industrial machinery and equipment	7.3%	6.3%
357	Office, computing and accounting machinery	3.1%	3.3%
359	Miscellaneous machinery, except electrical	3.4%	-
362	Electrical industrial apparatus	3.4%	-
363	Household appliances	-	2.9%
366	Communications equipment	-	2.9%
367	Electronic components and accessories	6.0%	7.8%
371	Motor vehicles, motor vehicle parts and accessories	8.5%	5.2%
372	Aircraft and parts	5.3%	5.9%
382	Measuring and controlling instruments	5.3%	5.2%
	Group Total	64.9%	61.8%

Robotics

Of the total responding plants 36.9 percent report their plans include purchase of robotic devices in the next three years. That's a growth of 70.8 percent from our survey conducted in the summer of 1981. Last year the figure was 33.9 percent; two years ago, 30.5 percent; three years ago, 21.6 percent.

Industries heavily committed to robotic purchases include: Hardware (SIC 3429), forgings and stampings (SIC 346), valves and fittings (SIC 3494), farm and garden machinery (SIC 3523), metalworking machinery (SIC 354), general industrial machinery and equipment (SIC 356), motor and control builders (SIC 3621, 3622), electronic components and accessories (SIC 367), motor vehicles (SIC 3711), motor vehicle parts and accessories (SIC 3714), aircraft (SIC 372) and measuring and controlling instrument industries (SIC 382).

Robot applications and planned usage by those intending to purchase these devices, as reported in the last two surveys, break down as follows:

	Currently Use		Planned Purchase	
Robot Applications	1984 Survey	1985 Survey	1984 Survey	1985 Survey
Arc Welding	16.6%	19.4%	9.9%	8.4%
Spot Welding	6.7%	7.8%	5.3%	4.3%
Assembly	32.0%	30.4%	15.8%	15.8%
Machine Load/Unload	41.2%	47.4%	24.4%	18.6%
Material Handling	24.1%	28.5%	13.9%	12.6%
Spray Painting	16.1%	17.4%	10.6%	10.9%
Other	3.9%	5.6%	1.4%	1.5%

Base: Respondents planning robot purchases 1985-87

(continued)

Lasers

Lasers are capturing more of your attention, your applications and your capital dollars as 15.9 percent of the respondents report their plans include purchase in 1985-87. This is up from the 14.1 percent of respondents reported in last year's survey. Lasers will be purchased for cutting operations (28.1%), for welding (25.6%), for drilling (14.1%), and for heat treatment (7.2%). A whopping 53.8 percent report they'll use lasers for gaging/measurement. Almost 90 percent of those intending to buy lasers are located in plants employing 100 or more persons; almost 50 percent are in plants employing 500 or more. Only 11.2 percent of total respondents are located in plants employing fewer than 100 persons.

Major laser purchase activity is centered in four industry groups; individual industries showing important interest are indicated:

SIC	Industry	Percent of Respondents Planning Laser Purchase
34	**Fabricated Metal Products** Heavy activity: Valves and Fittings	13.7%
35	**Machinery, except Electrical** Heavy activity: Engines and turbines, farm machinery, metalcutting machine tools, tools and dies, machine tool accessories, special industry machinery, pumps and compressors, miscellaneous machinery, n.e.c.	36.6%
36	**Electrical Machinery** Heavy activity: Electric motors, industrial control, communication equipment, electronic components	24.0%
37	**Transportation Equipment** Heavy activity: Motor vehicles, motor vehicle parts and accessories, aircraft, aircraft engines and parts, aircraft equipment, n.e.c.	17.5%
38	**Instruments** Heavy activity: Measuring and controlling instruments, medical, dental and surgical equipment	6.8%

Electrical Discharge Machines (EDM)

The use of EDM continues to broaden industry-wide. Over 11 percent of the total respondents (11.3%) plan EDM purchases over the next three years, up from 10 percent reported in last year's survey. 61.8 percent of these plants currently operate EDM which means almost four out of ten respondents are making initial purchases. 64.3 percent of the plants planning for EDM will purchase wire-cut machines, 37.2 percent RAM (standard). About 10 percent will purchase both types of EDM approximating last year's performance.

Respondents planning purchase of EDM over the next three years are spread over 65 industries (Standard Industrial Classifications). Almost 60 percent of these plants are located in the following listed industries:

SIC	Industry	Percent of Respondents Planning EDM Purchase
3429	Hardware, n.e.c.	3.9%
3451	Screw machine products	2.9%
3462	Iron and steel forgings	2.9%
3469	Metal stampings, n.e.c.	2.9%
3544	Special dies, tools, fixtures, molds	11.6%
3545	Machine tool accessories	4.8%
3599	Machinery, except electrical, n.e.c.	5.3%
3622	Industrial controls	2.4%
3679	Electronic components, n.e.c.	3.9%
3714	Motor vehicle parts and accessories	6.3%
3721	Aircraft	1.9%
3724	Aircraft engines and engine parts	3.9%
3728	Aircraft equipment, n.e.c.	2.9%

Over 77 percent of those planning EDM purchases in 1985-87 are located in plants employing more than 100 persons.

Numerical Control

Numerically controlled stand-alone machines continue to take a larger share of your metalcutting, metal forming, gaging and assembly investment. Over the last nine years the number of plants reporting that their purchase plans included NC or CNC equipment jumped from 34.4 percent of the respondents to the 1977 survey to 52.1 percent this year—a gain of over 50 percent! And over six out of ten respondents (62.8%) report current use of NC or CNC equipment. 77.7 percent of the total respondents planning to purchase CNC in the next three years employ 100 or more persons (30 percent in plants of 500 or more). 57.4 percent of these plants planning CNC purchase will spend 40 percent of their investment appropriations with offshore CNC suppliers.

Percent of Respondents Planning CNC Purchase

Equipment Type	1986	1986	1987
Machining Centers, Horiz. - Y axis less than 27 in.	10.3	10.1	6.2
Machining Centers, Horiz. - Y axis more than 27 in.	12.9	8.9	7.3
Machining Centers, Vert. - Y axis less than 20 in.	16.0	9.1	6.3
Machining Centers, Vert. - Y axis more than 20 in.	12.9	7.3	5.8
Turning, Horiz. - Less than 13-in. Chuck	23.6	16.9	9.3
Turning, Horiz. - More than 13-in. Chuck	12.0	8.5	5.6
Turning, Vert. - Less than 30-in.-dia. table	3.3	2.7	2.1
Turning, Vert. - More than 30-in.-dia. table	2.7	3.1	3.6
Boring	8.2	8.2	3.5
Drilling	10.7	7.7	3.8
Grinding	13.2	8.3	6.0
Milling	15.5	10.0	5.8
Punching	8.8	5.8	4.6

The chart above shows the types of CNC machines that the plants planning purchase intend to buy over the next three years, with year of expected purchase indicated.

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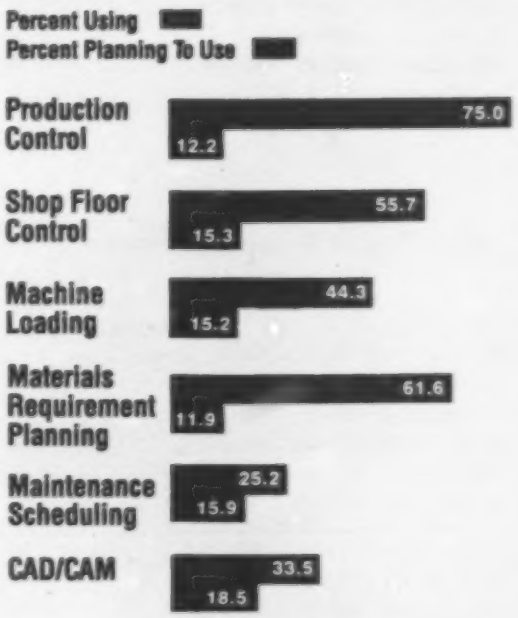
Computers

Three-quarters of you (78.7%) plan to apply computers in your manufacturing operations over the next three years. While many of you already use computers in a portion of your manufacturing operations, and are applying more of them to additional operations, about half of you are making initial applications. The fact is, computer uses for manufacturing purposes have exploded. Five years ago only 30.3 percent of you reported your plans included use of computers for manufacturing.

Use of computerized data systems in your plants continues to expand as your needs to reduce your manufacturing costs through better control and improved product quality accelerate.

(continued)

Computerized Data Systems' Usage



CAPITAL SPENDING

Spending Patterns

For each of the eight production equipment categories shown below, the industries that are listed account for the bulk* of the total 1985 investment in that type of equipment. Industries not listed do not invest significantly in equipment of that type.

You can compare your company's investment pattern with your industry's spending plans by determining the percentage of your capital investment budget that will go for each of these eight equipment categories.

**These industries account for 75 percent or more of the planned investment for these types of equipment according to our survey.*

Cleaning/Finishing Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools, hardware	9.7%
344	Fabricated structural steel products	10.5%
345	Forgings and stampings	5.4%
346	Ordnance and accessories	9.4%
349	Miscellaneous fabricated metal products	7.4%
351	Engines and turbines	11.5%
352	Farm and garden machinery	9.1%
358	Refrigeration and service industry machinery	8.1%
361	Electrical transmission and distribution equipment	6.6%
363	Household appliances	20.0%
364	Electrical lighting and wiring equipment	16.2%
366	Communication equipment	6.9%
371	Motor vehicles, motor vehicle equipment	12.1%
372	Aircraft and parts	9.7%

Plastic Molding Equipment

SIC	Industry	Percent of Total Capital Expenditures
343	Heating equipment, except electric and plumbing fixtures	7.7%
357	Office, computing and accounting machinery	5.9%
358	Refrigeration and service industry machinery	6.6%
361	Electrical transmission and distribution equipment	4.0%
362	Electrical industrial apparatus	4.7%
363	Household appliances	5.1%
364	Electrical lighting and wiring equipment	5.2%
365	Radio and TV sets	10.0%
367	Electronic components and accessories	3.1%
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	4.8%
371	Motor vehicles, motor vehicle equipment	1.4%
381	Engineering, laboratory, scientific and research instruments	2.6%
382	Measuring and controlling instruments	2.4%
384	Surgical, medical and dental instruments and supplies	10.6%

Weld/Rivet/Braze Equipment

SIC	Industry	Percent of Total Capital Expenditures
343	Heating equipment, except electric and plumbing fixtures	2.8%
344	Fabricated structural steel products	10.2%
346	Ordnance and accessories	7.5%
349	Miscellaneous fabricated metal products	4.3%
351	Engines and turbines	4.9%
352	Farm and garden machinery	12.6%
353	Construction, mining, oil field and material handling equipment	10.8%
354	Special industry machinery	5.8%
356	General industrial machinery and equipment	4.1%
358	Refrigeration and service industry machinery	8.2%
361	Electrical transmission and distribution equipment	6.1%
363	Household appliances	6.3%
371	Motor vehicles, motor vehicle equipment	5.2%
376	Guided missiles, space vehicles and parts	6.5%

Heat Processing Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools, hardware	2.8%
344	Fabricated structural steel products	2.7%
345	Screw machine products	2.5%
346	Forgings and stampings	5.6%
351	Engines and turbines	4.8%
353	Construction, mining, oil field and material handling equipment	1.2%
354	Metalworking machinery and equipment	2.5%
356	General industrial machinery and equipment	2.8%
366	Communication equipment	2.9%
371	Motor vehicles, motor vehicle equipment	3.0%
372	Aircraft and parts	2.7%
376	Guided missiles, space vehicles and parts	3.5%

CAPITAL SPENDING

Metalcutting Machine Tools

SIC	Industry	Percent of Total Capital Expenditures
345	Screw machine products	55.8%
348	Ordnance and accessories	33.6%
349	Miscellaneous fabricated metal products	42.9%
351	Engines and turbines	51.9%
352	Farm and garden machinery	32.2%
353	Construction, mining, oil field and material handling equipment	54.2%
354	Metalworking machinery and equipment	66.0%
355	Special industry machinery	59.3%
356	General industrial machinery and equipment	52.9%
359	Miscellaneous machinery, except electrical	72.6%
362	Electrical industrial apparatus	32.0%
366	Communication equipment	32.3%
371	Motor vehicles, motor vehicle equipment	30.9%
372	Aircraft and parts	59.5%
382	Measuring and controlling instruments	30.7%

Assembly Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools, hardware	18.7%
348	Ordnance and accessories	25.0%
357	Office, computing and accounting machinery	26.3%
358	Refrigeration and service industry machinery	12.9%
361	Electrical transmission and distribution equipment	20.1%
362	Electrical industrial apparatus	23.7%
363	Household appliances	15.5%
364	Electrical lighting and wiring equipment	27.0%
365	Radio and TV sets	50.0%
366	Communication equipment	28.9%
367	Electronic components and accessories	33.2%
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	40.8%
371	Motor vehicles, motor vehicle equipment	13.9%
382	Measuring and controlling instruments	24.4%
384	Surgical, medical and dental instruments and supplies	16.9%

Gaging/Inspection/Testing Equipment

SIC	Industry	Percent of Total Capital Expenditures
345	Screw machine products	10.5%
348	Ordnance and accessories	11.9%
351	Engines and turbines	8.7%
353	Construction, mining, oil field and material handling equipment	7.2%
356	General industrial machinery and equipment	6.7%
357	Office, computing and accounting machinery	12.6%
361	Electrical transmission and distribution equipment	6.9%
362	Electrical industrial apparatus	8.0%
366	Communication equipment	8.2%
367	Electronic components and accessories	13.9%
369	Miscellaneous electrical machinery, equipment, supplies, n.e.c.	6.3%
371	Motor vehicles, motor vehicle equipment	7.4%
372	Aircraft and parts	7.6%
381	Engineering, laboratory, scientific and research instruments	19.5%
382	Measuring and controlling instruments	13.0%
384	Surgical, medical and dental instruments and supplies	6.9%

Metal Forming Machinery and Equipment

SIC	Industry	Percent of Total Capital Expenditures
342	Cutlery, hand tools, hardware	21.4%
343	Heating equipment except electric and plumbing fixtures	25.0%
344	Fabricated structural steel products	35.9%
345	Screw machine products	16.3%
346	Forgings and stampings	41.8%
349	Miscellaneous fabricated metal products	12.7%
352	Farm and garden machinery	25.7%
353	Construction, mining, oil field and material handling equipment	10.3%
358	Refrigeration and service industry machinery	32.9%
361	Electrical transmission and distribution equipment	21.2%
363	Household appliances	23.0%
364	Electrical lighting and wiring equipment	23.1%
371	Motor vehicles, motor vehicle equipment	17.2%
379	Miscellaneous transportation equipment, n.e.c.	32.9%
381	Engineering, laboratory, scientific and research instruments	23.4%

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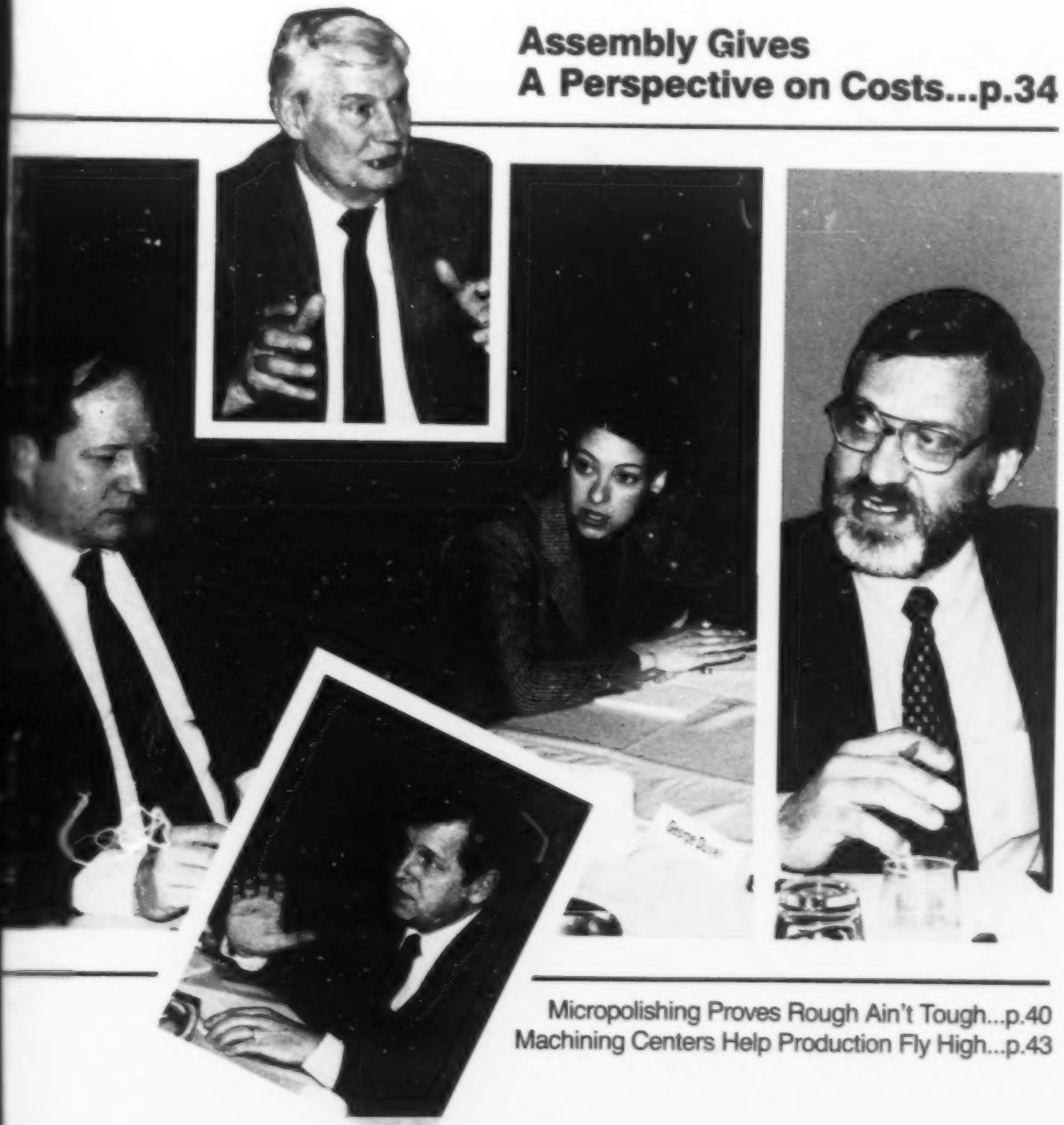
PRODUCTION

MAY 1985

Assembly Gives A Perspective on Costs...p.34



Micropolishing Proves Rough Ain't Tough...p.40
Machining Centers Help Production Fly High...p.43

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PRODUCTION®

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Assembly Gives a Perspective on Costs

PRODUCTION Round Table participants conclude that a careful look at assembly operations can tell a lot about the efficiency of all prior fabrication operations, product design, preformance of outside suppliers, and more 34

Micropolishing Proves Rough Ain't Tough

Tighter part tolerances and greater durability make micropolishing an important process option 40

Machining Centers Help Production Fly High

Aerospace manufacturer is setting new production standards with three 5-axis CNC machining centers 43

Control Is the Name of the Game

Taming the countless production control variables is the vital job assigned to an integrated blend of three sophisticated control systems 46

Westec '85 Highlights

Some of the products displayed at the Los Angeles show 48

Coupling 'Trims' Weed Eator Costs

The switch to a cold-headed coupling in the manufacture of gasoline lawn trimmers reduces part and assembly costs 53

First-Part Inspection Slashes Scrap

CNC bridge-type coordinate measuring machine reduces part inspection time by 90% and slashes scrap by 80% 55

International Tool & Manufacturing Show

A sampling of exhibits of the May 6-9 show 56

Wrap-Up 58

- Robot Speeds Assembly
- Cell Machines Parts Family
- The 'Connecting Rod' Connection
- Custom Solution

5 EDITORIAL

13 NEWSBITS

Manufacturing Outlook
Washington Impact
Industry Report
Technology Updates
Robotics/Automation
Assembly

27 BUILDERS' CORNER

Thomas Hilkert
The Bullard Co.

31 STRICTLY PERSONAL

61 NEW LITERATURE

64 NEW EQUIPMENT

77 ADVERTISERS INDEX

79 FOR YOUR INFORMATION

81 READER SERVICE CARD

THE COVER:

Round Table participants pinpoint dimensional tolerances, material handling, inventory control, consistent part quality, vendor relationships and strategic planning as major factors requiring attention in order to provide efficient assembly operations.

NEXT MONTH:

Is the quality push for real? Several U.S. manufacturers and suppliers say YES. Efforts of large and small companies will be detailed along with the results and overall benefits being obtained.

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China in Buying Mood

At a 7000-sq-ft mini-machine tool show in Shanghai (less space than some of the booths at IMTS events in Chicago) orders were placed for $10.5-million worth of equipment with another $30 million to follow.

The order figures are from an independent survey conducted by a representative of the U.S. Department of Commerce. The show, "The Second U.S.A. Machine Tool Exhibition," was sponsored by the National Machine Tool Builders' Assn., also sponsor of the biennial IMTS. James A. Gray, NMTBA president, says, "We don't yet know the total attendance but we had 22,000 on one day. Based on the success of this exhibition, we plan to go back with another larger one in 1986, and the Chinese representatives are already working to help us."

Only 23 companies exhibited but products ranged from CNC machining centers, robots, grinding and turning machines to EDM, sawing equipment, gear cutting machines and cutting tools.

Abrasives Grind Away

An Abrasive Industry Forecast by Robert N. Hamilton, vice president, Abrasives Marketing Group, Norton Co., Worcester, MA, predicts 1985 will be a good year for the abrasives industry, with strong emphasis on product development and growth in new markets.

Grinding wheels made with CBN (cubic boron nitride) abrasive will continue to grow faster than traditional abrasive products. The focus will be on developing highly specialized vitrified and metal bonds for specific production applications.

Creep-feed grinding will also continue to grow as the number of machines suitable for this method increases. This type of grinding is a good example of an application where process technology is as important as product research.

High performance products—both bonded and coated—based on new generations of zirconia alumina will come into use. Major development work will be done on backings both stitched and film types.

The electronics industry and the increasing use of ceramics throughout industry will open new market areas that offer high growth potential.

Air Force To Link Artificial Intelligence and Manufacturing

Dr. Vincent J. Russo, director of Manufacturing Science programs for Aeronautical Systems Div.'s Materials Laboratory at Wright-Patterson AFB, OH, heads a team of scientists that hopes to interest industry in artificial intelligence (AI) programs for batch manufacturing.

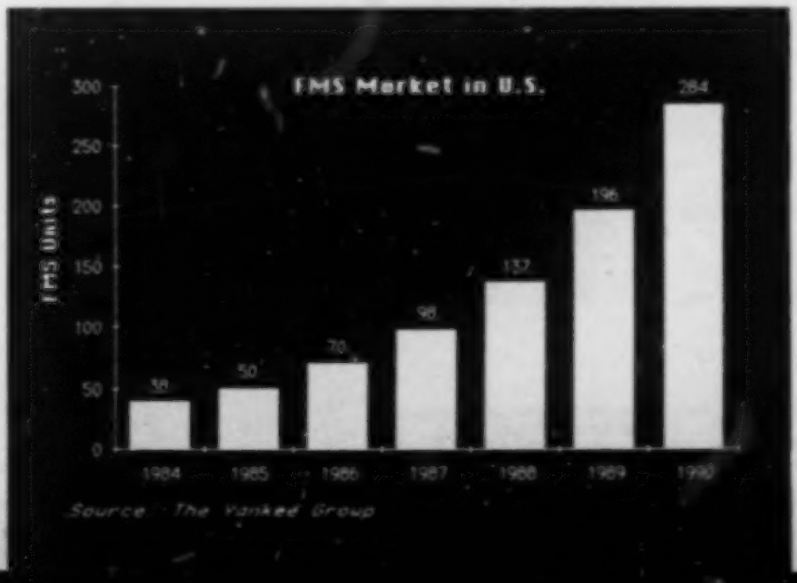
The Air Force seeks industry support for an Institute for Artificial Intelligence in Manufacturing to be established at a mutually determined university and serve as a national resource center for research into AI concepts for manufacturing. The Institute will also become a new source of people trained in both AI and manufacturing.

Flexible Manufacturing's Future

Flexible manufacturing will improve U.S. industrial productivity over the next decade, but flexible manufacturing systems will not be widespread, indicates The Yankee Group, a Boston-based market and technology research firm.

Seen as a progression from NC machine tools through flexible manufacturing cells and finally FMSs, the development is one that not all manufacturers will adopt. As seen in the chart, only a few hundred will install full systems in the next five years. However, The Yankee Group estimates the market for FMSs and FMCs will rise sharply to $1.8 billion in 1990 from last year's $262 million.

In 1984, 56 percent of all FMSs were used for manufacturing machinery and 41 percent for manufacturing transportation components. Predictions call for the construction and material handling industries to comprise 12 percent of the user market by 1990. ■



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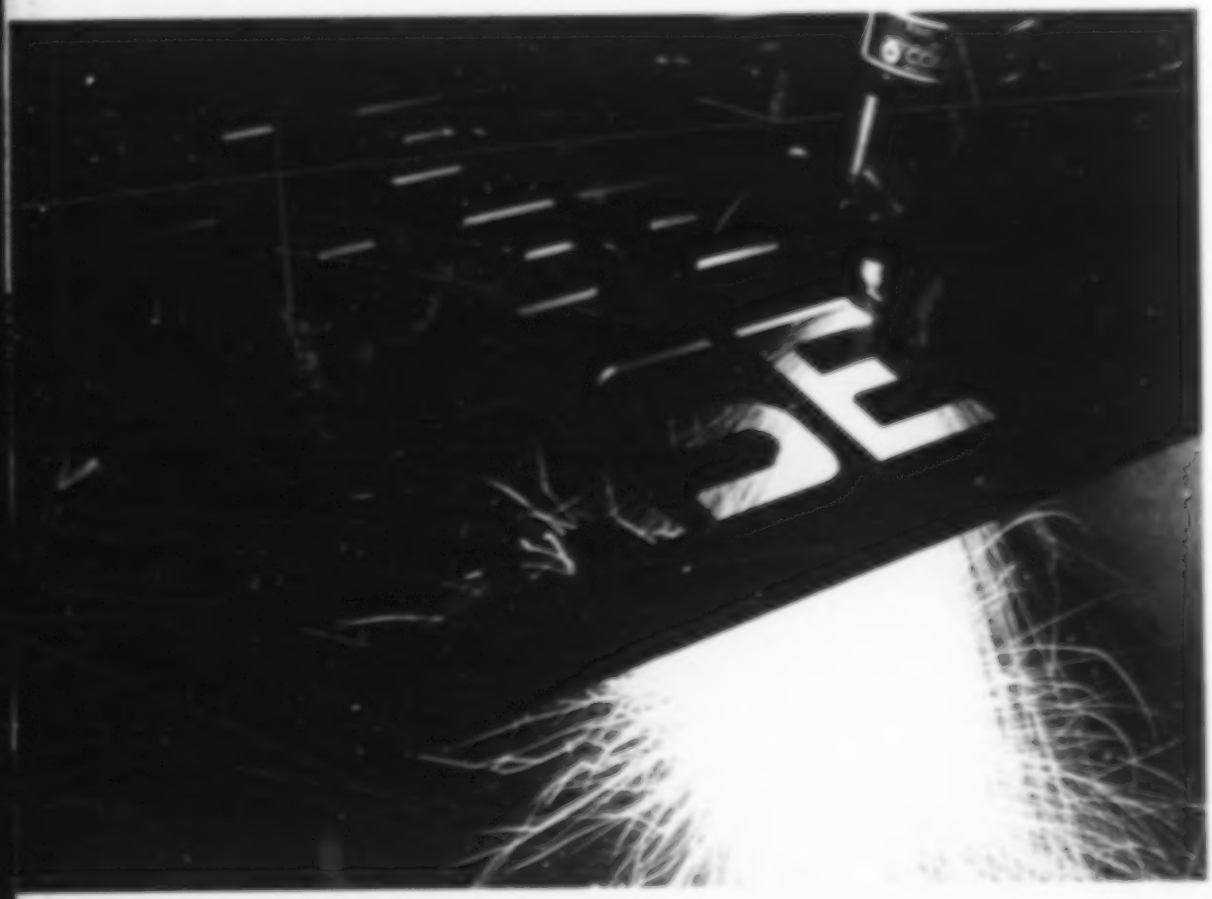
PRODUCTION

JULY 1985

The Incredible Laser...p.41



Machining at 7000 SFM!...p.48
FMS Masters Factory Efficiency...p.51

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Vol. 96 No. 1

PRODUCTION®

July 1985

The Incredible Laser
Its flexibility, versatility and precision characteristics are unequaled as a manufacturing tool 41

Interrupted Cut on Gray Iron at 7000 SFM!
Silicon nitride cutting tools show great promise at Ford because of their ability to withstand interrupted cuts, handle high speeds and feeds 48

FMS Masters the Factory
A system of four sophisticated DNC machining centers replaces 27 machines while slashing inventory from 30 to six days 51

Robots 9
World's largest exposition focused on manufacturing solutions through the integration of technologies 54

Material Handling Cools Refrigerator Costs
A combination of standard and custom material handling systems ensures a smooth, coordinated flow of production parts from fabrication through final assembly 60

The Case of the Mysterious Measurements
An ultra-precision CMM ought to pinpoint quality problems. But when a blip showed up in the learning curve with the CMM, quality was not the main problem; understanding the process was 62

Wrap-Up 65

- CAD Clones Cutting Tools
- 'Model' Material
- Robot Handles Discs
- Flexible Special Machine

6 EDITORIAL

11 NEWSBITS
Manufacturing Outlook
Washington Impact
Technology Updates
Robotics/Automation
Industry Report
Assembly

23 BUILDERS' CORNER
John F. Rampe
Rampe Finishing

27 STRICTLY PERSONAL

68 NEW LITERATURE

72 NEW EQUIPMENT

76 BOOKMART

82 ADVERTISERS INDEX

83 FOR YOUR INFORMATION

85 READER SERVICE CARD

THE COVER:
A CO_2 laser cuts .125 steel like butter demonstrating its flexibility for metalworking. Lasers also 'shine' for drilling, welding, marking and other applications. Photo courtesy of Coherent General, Sturbridge, MA.

NEXT MONTH:
Manufacturing strategies are vitally important in order to plan the utlization and implementation of the most productive processes, so say a group of seven PRODUCTION Round Table participants.

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TECHNOLOGY UPDATES

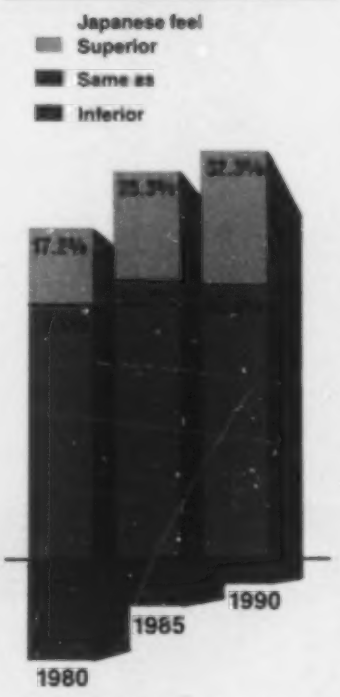
Technological Superiority Overseas

In a recent survey among 1623 of Japan's leading firms by the Japanese Economic Planning Agency, nearly 90 percent expressed confidence that their technological capacity has already caught up with or surpassed that of U.S. companies. Furthermore, about 60 percent indicated they intend to emphasize independent development of new technologies and nearly one-third of those polled believed it would become increasingly difficult to acquire foreign technologies in the future.

The annual survey, conducted since 1961, also showed nearly 80 percent of Japan's manufacturing firms cited technological innovation as the most important factor in determining their capital investments, which are expected to register about 5 percent annual growth in the next three years.

More than 70 percent intend to place strong emphasis on labor-saving and efficiency enhancements in promoting their capital investments, the survey said. About 50 percent of the firms indicated they are currently making direct investments overseas, and a majority have plans to expand these investments in the next five years. Asia is targeted for most of the increased investment with the U.S. and Canada ranked next and Western Europe mentioned third.

Japan vs. U.S. Technology
(Survey of Japanese Companies)



Source: Japan Economic Journal

Walking Robots Next?

In several projects at universities in this country, mechanical walking technology is being developed which could have manufacturing applications. Specifically, robots that could walk in addition to doing mechanical arm manipulations would make further automation of the factory possible.

One such machine is the six-legged Adaptive Suspension Vehicle designed by Robert B. McGhee, an electrical-engineering professor at Ohio State University and pioneer in walking machinery. Under contract to the Pentagon's Defense Advanced Research Agency, the research effort currently is focused on providing the Army with a vehicle capable of a variety of walking motions on uneven surfaces.

McGhee's brainchild which weighs as much as a medium-sized truck will be ready for testing by the end of this summer. Fifteen on-board minicomputers will be programmed for the stroll on uneven terrain and a special radar system using infrared light to produce a 3-D image of the ground will instruct the machine where to step. ■

ROBOTICS/AUTOMATION

Ford Invests in American Robot

Under the terms of a recent major agreement, Ford Motor Co. will invest nearly $20 million in equity and R&D funding in American Robot Corp., Pittsburgh, to develop Computer Integrated Manufacturing (CIM) technology.

ARC already has a strong base in manufacturing intelligent industrial robot and vision systems. Recently the company has expanded into broad software-based CIM systems. These systems integrate robots, vision systems, workcell controllers, CAD systems and mainframe computers using ARC's proprietary CIM software.

A group dedicated to support Ford's CIM needs has been formed and will be headed by Larry Lewis. The CIM group will be responsible for systems analysis and evaluation of Ford's plants to determine the hardware and software requirements for installing CIM systems.

According to Romesh Wadhwani, chairman and CEO of ARC, "The potential payback from this new concept of 'white collar robotics' is even greater than that